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BRUISING OF PACIFIC NORTHWEST APPLES DURING SHIPMENT AND MARKET DISTRIBUTION

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Previous investigations of apple bruising have related to damage done during picking, hauling from orchard to warehouse, storing unpacked fruit, and during cleaning and packing (1,2,3,4).1/ The relation of the type of package to apple bruising can best be determined after the apples have undergone shipment and delivery to the retail store. Experiments designed to do this with some of the packages and packaging materials used in commercial apple packing in the Pacific Northwest were carried out during 1949-1950. In these tests an attempt was made to determine the increase in bruises caused by (a) car loading, (b) transportation in refrigerator cars, and (c) handling and delivery from the car to the retail store. The tests were made from Wenatchee, Washington, to the metropolitan area of New York, N.Y. or to Washington, D. C., with repetitions in 3 series of shipments, beginning in the fall and ending in early spring. At the request of the apple industry newly designed Ply-Veneer boxes were included in the two late shipments.

Packaging

Apples of the Richared strain of the Delicious variety from one orchard at Orondo, Washington, were used throughout the experiments. With the exception of the fruit packed in the Ply-Veneer containers all apples were picked October 6 at a late-optimum stage of maturity (159 days after full bloom). The fruit was packed the same day at the packing house of a grower who was selected because past performance records had shown a minimum of bruising in his harvesting and packing operations.

A total of 194 test packages of 100-size apples were packed by 2 packers of similar skill and placed in cold storage (31°F.) at the orchard. Packages required for the fall shipping tests were carefully transported to the laboratory storage (31°F.) October 6 to 7. Characteristics of the packages and packaging material are given in table 1. The slightly larger packages 3 to 5 were designed by the orchardist to accommodate the 4-way corrugated pads and indent paper tier pads used in his regular pack; and packages 6 to 8 had larger dimensions to accommodate the trays used in tray-packs.

1/ 1. Research Dept.
1949. Causes of bruises in packing apples. Wash. State Apple Com. 1949 Report, 13 pp. (Processed)

2. _____
1949. What Makes a Good Packer? Wash. State Apple Com. Research Digest No. 36, 4 pp.

3. Smith, E., and Wright, T. R.
1948. Source of Apple Bruises. U. S. Dept. Agr. H.T.&S. Office Report No. 190, 8 pp. (Processed)

4. Smith, E., Adams, D., and Wright, T. R.
1949. Investigation of Apple Bruising. U. S. Dept. Agr. H.T.&S. Office Report No. 211, 17 pp. illus. (Processed)

At the time of packing, the boxes appeared adequately filled and where fruit wraps were used the bulge was approximately 1 inch, being comparable to that of the commercial pack; - by the time the apples were transported to the laboratory however, the fruit had settled in the paper wraps sufficiently to indicate a light pack and subsequent weighings showed an average net weight of 38.7 pounds. As a preliminary check to indicate whether such a light pack, which proved to be "slack" before delivery, would result in more or less bruising than a heavy or "tight" pack, apples of similar size were wrapped and packed 113 to the box, giving net weights of approximately 43 pounds and gross weights of 51 to 51-1/2 pounds.

Evaluation of Bruise Occurrence

Templates having 1/2- and 3/4-inch perforations were used at all times where bruises were counted and any bruise having a single dimension between 1/2- and 3/4-inch was recorded as "slight", whereas, those measuring 3/4-inch or more were classified as "severe." An arbitrary standard was adopted whereby a determination could be made of the percentage of fruits in a given container that sustained bruises in excess of what might be tolerated without some degree of discrimination. To distinguish this class, any fruit having at least 3 slight bruises or 1 severe plus one other bruise of 1/2-inch minimum dimension was recorded as "multi-bruised." While many of the fruits thus classified would not be considered badly blemished because of bruises, the limits set up for the multi-bruised apples was considered a desirable industrial objective to work towards and provided a convenient measure of the protection afforded by the different packages tested.

Immediately after packing, 15 (3 of each type) random samples of packages 1 to 5 inclusive (table 1) were taken to the laboratory, opened and a determination was made of the average initial bruising which had occurred during picking and packing. These fruits were not used further in the tests since they could not be repacked without incurring an indeterminate number of additional bruises. It was possible, however, to count the picking and packing bruises in the tray-packs (No's. 6 to 8, table 1) and replace the apples in the containers without an essential increase in bruises. Consequently, with this type of package, the evaluation of the initial (picking and packing) bruises was made on the identical apples used for shipping tests.

A similar procedure was followed in determining bruises caused during car loading. For this, the packages were carefully moved from the laboratory to a shipping warehouse where they were placed on a conveyor belt which carried them into the refrigerator car. Here a workman stacked them in loading position without using more or less caution than is customarily used in car loading. Thereupon the packages were carefully removed and returned to the laboratory for bruise counting, and the increase in bruising over that attributed to picking and packing was ascribed to loading.

Shipping Tests

At the beginning of the fall shipping period two shipping tests were made with standard box packs, having the customary sulphite paper liners, to determine differences in bruising when the boxes were placed in the top and bottom layers of

stacks at the doorway, quarter-length and against the bunker of the car, and in a middle layer at quarter-length of the car. From these tests (table 2) it was concluded that the top and bottom layers at the bunker in the head end of the car would be satisfactory positions for general test package placement in subsequent shipping tests.

The packages used for transit bruising tests were carefully placed in the predetermined positions in refrigerator cars as they were being commercially loaded. At destination, the test packages were carefully removed by a staff member as the cars were being unloaded. The increase in bruising over that attributed to picking, packing, and loading was considered as having occurred in transit.

In determining the bruises caused between the refrigerator car and the retail store, the packages were also carefully placed in the car at shipping point, but at destination were removed, warehoused and delivered to the retail store through commercial channels, whereupon bruises were counted and the increments over picking, packing, loading, and transit bruises were computed.

To facilitate bruise counting after transit and after delivery to retail outlets, shipments to chain stores were chosen for the inclusion of test packages. In addition to these tests, comparable packages of standard boxes with sulphite paper liners were placed in cars destined to a New York auction to secure a comparison of bruises when handling apples through auction channels.

Market demand prevented adherence to the original plan of placing 4 test packages of a given type (2 in the top layer and 2 in the bottom layer) in shipments to the New York area during each of the 3 seasonal series of shipments. It was not possible to secure commercial loads of tray-packs to New York, therefore all tray-pack boxes and cartons (items 6, 7, and 8, table 1) for the fall series were loaded in one car shipped to Washington, D. C. The tray-packs and cartons for the winter and spring series were combined in an intermediate, March 30th, shipment to make a full stack across a car in a load of standard boxes to the New York area. The tray-packs and cartons in this car were separated from the standard boxes by a bulkhead.

Severe weather at shipping point and car shortages delayed the winter series until March 11, and this was followed by the third series on April 13, when, in both instances, several types of packages were shipped in the same car.

These variations between the shipping tests, indicated in table 3, make strict comparisons between packages in any one shipment period of questionable value, but by using averages from the results of the three series of shipping tests, comparisons become of more value in showing the relative extent of bruising during car loading, transit and terminal market distribution, and differences in protection from bruising afforded by various packages and packaging material.

Package Protection

A comparison of the bruising data secured after delivery of apples to retail stores throughout the 3 shipping periods (table 4) shows that the use of 4-way corrugated pads gave apples added protection from bruising. The protection

was more pronounced with respect to severe than to slight bruises, there being 52.6 per cent more severe bruises in boxes with paper liners than in those with corrugated pads. Large bruises having a dimension greater than 1 inch were counted in the winter and spring tests. Apples in boxes having corrugated pads reached the retail store with an average of 3.5 of these large bruises compared with 15.4 per box where paper liners were used.

Tier pads between the layers of apples in a box generally reduced the number of slight bruises, and there were no great differences between the three types of pads used (table 4). There was, however, considerable effect of tier pad on preventing bruises of 3/4-inch and larger and lessening the percentage of apples classified as "multi-bruised." In comparing the total number of bruises on apples packed in boxes with and without tier pads, crepe paper pads (fig. 1) gave a reduction of 14.1 percent, indent paper pads (fig. 2) 16.9 percent and Kimpak cellulose pads (fig. 3) 28.4 percent. The percentage of multi-bruised apples showed even wider differences.

It would appear from table 4 that the boxes lined with 4-way corrugated pads and having Kimpak cellulose tier pads (fig. 3) might give greater protection than the various tray-packs but this conclusion would be erroneous because, as previously explained, all of the tray-packs were subjected to an extra handling when securing data on car loading bruises. Therefore, the tray-packs gave better protection than data in table 4 would imply.

Differences in bruises between the two types of commercial trays used, or between the use of the same kind of tray in wood boxes and fibreboard cartons, were not great enough to be of importance. The tray-packs were not well-filled and further tests are needed to determine if a heavier pack would have resulted in more or less bruising.

Preliminary tests between heavy and light packs in wood, and in Ply-Veneer boxes, with apples in paper wraps show (table 5) that the heavy packs resulted in decidedly more bruising in all excepting the standard box with sulphite liner. Although the limited number of boxes used in these tests make comparisons between package types of questionable value, the average results of all the heavy and light packs, however, are pertinent and indicate that the exceptionally light packs used in these tests were not as conducive to bruising as is generally supposed and that heavy packs probably contribute substantially to the increase of bruises during car loading, transit and terminal market distribution.

New Packages

At the request of the Washington State Apple Commission, made after the season's work program was underway, there were included in the winter and spring series of shipping tests 4 new packages that are in a developmental stage. These are indicated in table 1 as "A", "B", "C" and "D" Ply-Veneer" and are illustrated in figure 4. Basically a new type of package and economically promising because of their lighter shipping weight (about 3 pounds), the packages were included in the tests to determine if they would stand handling through distributing channels without breakage, if the lighter construction would have a relationship to bruising and

if the package could be made in a form that would eliminate packing with a bulge. The material used was scored wood veneer, strengthened at the nailing edges with a light band of steel, and laminated between sheets of kraft paper. The packages were essentially of 2 types. Package A had the same inside dimensions as a standard apple box, and was made by fastening a sheet of Ply-Veneer around 3 sides of framed Ply-Veneer ends, with the top of the box being left open for packing with a bulge in the conventional manner, closure being made with a separate Ply-Veneer lid. Packages B, C, and D were made with a single piece of Ply-Veneer for top, bottom, and sides, the ends of the sheet being left as flaps of equal dimensions for closure of the top of the box by completion of its nailing to the ends of framed Ply-Veneer. Because of the added strength from a complete wrap-around of the Ply-Veneer, the wood veneer used in packages B, C, and D, was, in part, of less thickness than that used in package A (see table 1). Packages B, C, and D, were made deeper than A to provide for the flat-top closure, B and C being 1/2-inch deeper, and D - 3/4 inch deeper. Packages C and D had pads of shredded paper, referred to as "Jiffy" pads, between the fruit and the lid. The fruit in all boxes was packed with paper wraps, package A having sulphite paper liners, and B, C, and D, not having liners. Six boxes of each type were packed with Richared Delicious apples transferred from packed boxes of the grower who had furnished apples for the regular tests, but unfortunately it was not possible to secure fruit packed the same day as that used in the general tests. Slight evidence of apple scald on March 3, when the apples were transferred, indicated that the apples in the Ply-Veneer boxes were picked at a less mature stage than those in the regular tests. Three Ply-Veneer boxes of type A were packed with 100 size apples (light pack) and 3 with 113 size (heavy pack); 3 each of types B, C, and D, were packed with 100 and 80 size apples. Three standard boxes with sulphite liners were packed with 80 size apples for a check, making bruise comparisons between the new package and standard boxes in fruit of this size more reliable than in sizes 100 and 113, because of more comparable picking maturity.

There were no package failures through breakage or damage in the 24 Ply-Veneer boxes during shipment and market distribution in the New York area. From averages of bruises given in table 6, it is concluded that the Ply-Veneer boxes in general gave as good protection against bruising as the standard wood boxes having sulphite paper liners. The type B Ply-Veneer box, having flat top closure without a top pad, gave poorer protection than A, C, and D in both sizes 80 and 100, but this package when used with fruit of comparable maturity (size 80) gave as good protection against bruising as the standard box. Although the number of packages under test was too small to conclude that the Ply-Veneer boxes were superior to the standard box in giving protection against bruising, the data indicate that the containers could be used safely in commercial marketing trials either as a conventional bulge-pack container or as a deeper box with flat-top closure. With flat-top closure it would appear preferable to use padding material between the fruit and the lid. The flat-top boxes were all packed light, the net weight of the fruit being approximately 39 pounds; additional tests are desirable to show preferences between box depths of 11 and 11-1/4 inches when packed to hold 40 to 42 pounds of apples.

Bruises Attributable to Handling and Transportation

The examination of apples after car loading at shipping point, after transit when boxes had been carefully placed in and removed from the car, and after commercial car unloading and handling through normal channels to the retail stores, gave

an indication of the extent of bruising that occurred during different phases of shipment and distribution. Data in table 7 show that the greatest damage, more especially with respect to severe bruising, was done after transit between the refrigerator car and arrival at the retail markets. More bruising was done in carloading than during movement in transit from Wenatchee, Washington, to the area of New York. These results indicate that the handling of boxes is critical in causing apple bruises and points to the necessity for not permitting boxes to be dropped or thrown whether it be in warehousing, car or truck loading and unloading, or at any other point in market distribution.

An attempt was made to compare auction and chain store warehouse channels in respect to apple bruising at the retail level. Standard boxes with paper liners were unloaded from cars at the auction piers with hand or tractor-drawn trucks and stacked for auction display. No discrimination was shown by stevedores between test packages and those of the commercial shipments. It was not feasible to have the test boxes from the auction cars move through the New York wholesale jobbing houses to retail stores, hence, after having been commercially unloaded, these boxes were given a simulated handling comparable to that of loading and unloading trucks between the pier and the wholesale warehouse and between the latter and the retail store. Similar test boxes in cars consigned to chain store warehouses were unloaded onto pallets for movement to delivery trucks that carried them to the retail store along with regular deliveries from the same car. No extra handling was given these boxes by the investigators. Results given in table 4 show that apples going through the auction channel had more severe bruises than apples going to chain stores, but that the percentages of unbruised and multi-bruised apples, as well as the average number of slight bruises, were almost identical. This shows very clearly that although modern facilities were provided by the chain store for careful handling during car unloading and wholesale warehousing, the results were not very outstanding when other operations between the car and the retail chain store subjected the fruit to rough handling. It is apparent that more careful supervision of handling during market distribution through both chain store and auction channels is necessary to reduce the number of apple bruises.

Discussion of Other Factors Related to Bruising

Tray-Packs - Circumstances beyond our control prevented the use of comparable positions in the load for comparison of tray-packs and paper-wrapped packs. Owing to known variations in bruising with respect to the positions of the packages in the carload, (table 2) as well as to other unknown factors, it is not possible to show clearly the comparable extent of bruising of apples in these packages during transit and market distribution. Bruise counts made at Washington, D. C. with apples in the fall shipment of tray-packs showed a negligible increase during transit and market distribution regardless of the position of the package in the car and little difference between top and bottom trays of a given package. Apples in the combined shipment of March 30, however, showed considerable bruising with extensive damage to fruit in the packages loaded in the top layer of the car with less damage in the packages in the lower layers. It was noteworthy that in the top layer of packages more bruising occurred to apples in the top trays than in the bottom trays, whereas in packages loaded on the floor, either there were more bruises on apples in the bottom than in the top tray or differences were not apparent. As pointed out before, the test packages were not tightly filled, hence it

seems desirable to make further tests with tray-packs to determine the relationships of the tightness of the pack and manner of carloading to apple bruises during transit and market distribution. Should voids occur between packages in a carload it is possible that the crosswise loading of cartons or boxes - as was done in these tests, could result in extensive rocking of the stacks that would aggravate bruising, especially at the top of the load.

The bruising of apples during the car loading of tray-packs as shown in table 8, was not outstandingly different whether the trays were in wood boxes or in cartons, or whether either of the two types of trays was used. Although bruises caused by car loading were greater in the winter and spring tests than in the fall test, it is noteworthy that more damage was done to fruit in tray-packs in the January test than in the March test. As the difference was attributable to slightly better workmanship in loading in the March test, it emphasizes the importance of even a moderate degree of care in handling packages. In this instance, care in handling was more important in preventing bruises than differences between packages or difference in fruit ripeness occurring between January and March.

Relation of fruit ripeness to bruising - Handling practices were more important in contributing to bruising than fruit ripeness. As the season progressed, the pressure test of the apples changed from an average of 16.8 pounds on October 20 to 14.8 pounds on March 16 but in spite of this, the fruit shipped in the spring had less bruising when it reached the retail stores than either the fall or winter shipments (table 9). The bruising that took place in the transit period only was also less in the spring shipments than in the winter shipments, when, for some unknown reason, presumably rougher handling practices, it was the greatest (table 7). It is well known that as apples ripen and become softer they are more subject to bruising and demand greater protection but it is doubtful if package protection alone can prevent bruising if care in handling packages is disregarded.

Bruises from freezing during transit - The relationship of transit freezing to apple bruises was not contemplated in these tests but in the two cars shipped December 7 (table 3) evidence of apple freezing was observed in some of the test boxes at destination. Transit bruising in these packages was somewhat greater than in comparable packs not showing evidences of freezing. Protection against freezing should be given careful consideration in bruise prevention because apples are subject to severe bruise damage if handled while in a frozen condition.

SUMMARY AND CONCLUSIONS

Shipping tests with Richared Delicious apples in 8 variations of commercially used packages, and in 4 variations of a package now in the developmental stage, were made between Wenatchee, Washington, and eastern terminal markets. Bruise evaluation was made before and after carloading, after railroad transit and after handling from the refrigerator car to the retail market.

Corrugated paper pads at the top, bottom, and sides of wood boxes were effective in preventing many of the larger bruises. After arrival at retail markets 52.6 per cent more severe (3/4-inch and larger) bruises were found on apples in boxes with paper liners than in boxes with corrugated pads. Apples in boxes with

paper liners had an average of 15.4 very large(1inch or larger) bruises in contrast to 3.5 for those protected with corrugated pads.

A comparison of protection of crepe paper, indent paper, and Kimpak cellulose for tier pads between layers of apples showed that under the conditions of these tests the crepe paper resulted in 14.1 per cent less total bruises than were found in boxes without tier pads; indent paper tier pads had 16.9 per cent and Kimpak cellulose tier pads had 28.4 per cent less total bruises. The 3 types of tier pads were of approximately equal value in preventing slight (1/2 to 3/4 inch) bruises.

Tray-packs were effective in protecting apples from bruising. The type of tray or the use of trays in wood boxes or fibreboard cartons did not show marked differences in the extent of apple bruising.

Preliminary tests between heavy and light packs of wrapped apples showed that the heavy packs resulted generally in more bruising by the time the apples were delivered to the retail store. The relation of container fullness to bruises on apples in tray-packs has not been determined.

New and lighter apple boxes incorporating the use of wood veneer in construction satisfactorily withstood handling during shipment and market distribution and gave protection against bruising that compared favorably with the conventional wood box.

A much greater increase in apple bruises occurred while handling boxes from the refrigerator cars to the retail stores than during transit or during loading at shipping point. More bruising occurred while loading boxes in cars than during actual rail movement. Reducing impact from dropping or throwing boxes is imperative in apple bruise prevention.

Boxes unloaded at a pier for a New York auction and given a simulated handling to retail stores had apples with more severe bruises than similar boxes unloaded and warehoused on pallets and then delivered to chain retail stores. The average percentages of unbruised and multi-bruised apples following the two methods were essentially the same, however, showing that the benefit from having modern handling facilities at the unloading point was largely lost because of rough handling in delivery to the retail stores. Improvements in handling boxes during terminal market distribution offer outstanding possibilities in preventing bruised apples.

Tray-packs loaded across the car had more bruised apples in containers at the top of the load than in those nearer the bottom.

Care in handling packages had a greater relationship to apple bruising than differences in the ripeness of apples during the fall, winter and spring shipping seasons.

Freezing in transit in certain packages was associated with a greater number of bruised apples.

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TABLE 1 - TEST PACKAGE CHARACTERISTICS 1949-1950

Package No.	Symbol	Type	Inside Dimensions Width Inches	Depth Inches	Length Inches	Liners or Pads	Tier Separators	Bulge Inches
1	Std.	Box, wrapped	11-1/2	10-1/2	18	Sulphite paper	None	1
2	CP	" "	do	do	do	4-way corrugated pads.	None	3/4to 1
3	CPC	" "	11-3/4	10-3/4	18	do	Crepe paper	do
4	CPI	" "	do	do	do	do	Indent paper	1 to 1-1/4
5	CPK	" "	do	do	do	do	Kimpak Cellulose	3/4 to 1-1/4
6	BA	" tray-pack	12-1/8	11-3/4	19-3/4	None	Type A tray	None
7	BB	" "	do	do	do	do	Type B tray	None
8	CB	Carton "	12-1/8	11-7/8	19-3/4	do	Type B tray	None
9	A	Ply-Veneer,wrapped 1/	11-1/2	10-1/2	18	Sulphite paper	None	1 to 2-3/16 2/
10	B	Ply-Veneer,wrapped 3/	11-1/2	11	18	None	None	None
11	C	Ply-Veneer,wrapped 3/	11-1/2	11	18	Jiffy pad at top	None	None
12	D	Ply-Veneer,wrapped 3/	11-1/2	11-1/4	18	do	None	None

1/ Thickness of veneer--sides and bottom 3/16 in; ends 1/8"; lids 1/10 in.
2/ Bulge on light pack (100 size) 1"; on heavy pack (113 size) 1-1/2" to 2-3/16".
3/ Flat-top, bottom, sides and top, 1 piece of veneer, 1/8" thick.

TABLE 2 - RELATION BETWEEN APPLE BRUISING AND PACKAGE POSITIONS IN THE REFRIGERATOR CAR.1/
WENATCHEE, WASH. TO NEW YORK, N.Y. 1949

Package Position	Apples Examined Number 2/	Sound Apples Percent	Multi-bruised3/ Percent	Bruises per 100 Apples		
				Slight	Severe	Total
Doorway Stack4/	400	32.2	7.0	43.2	7.5	50.7
Quarter-length Stack4/	400	36.0	4.8	39.1	5.3	44.4
Bunker Stack4/	400	35.3	5.0	38.7	7.5	46.2
Top layer5/	600	48.3	10.0	65.3	10.0	75.3
Bottom layer5/	600	55.2	6.8	55.3	10.3	65.6
Quarter-length Top layer	200	53.0	7.0	61.5	5.5	67.0
Middle layer	200	59.5	5.0	50.0	6.0	56.0
Bottom layer	200	55.0	7.5	56.0	10.5	66.5

1/ Data represents averages from 2 shipping tests, each with standard wood boxes, paper liners, placed in top and bottom layers of stacks at doorway, quarter-length and against ice bunker and in middle layer of quarter-length stack, all at the center-lines of cars.

2/ Boxes held 100 apples, all of which were examined.

3/ Multi-bruised: Apples having at least 3 slight (1/2 to 3/4 inch) bruises, or one severe (3/4 inch or larger) plus one other bruise of 1/2 inch minimum dimension.

4/ Top and bottom layers.

5/ Doorway, quarter-length and bunker stacks.

TABLE 3 - SHIPPING TESTS FOR APPLE BRUISING STUDIES - 1949-1950

Series	Car No.	Condition	Shipping Date	Loading Point	Destination	Test Packages 1/
Fall	FGE 34523	Fair, old car	10-20-49	Cashmere	Waverly, N.J.	7 Std. - transit bruises
	FGE 37188	Fair, old car	10-22-49	Orcville	Garden City, N. Y.	7 Std. - " "
	WFE 68518	Good	10-27-49	Wenatchee	Waverly, N.J.	4 Std. - transit and market 1/
	WFE 60057	Fair	10-29-49	Cashmere	New York Auction	4 Std. - " " "
	WFE 68171	Good	11-4-49	Brewster	Waverly, N.J.	4 CPI - " " "
	WFE 66116	Good	11-4-49	Brewster	Waverly, N.J.	4 CPC - " " "
	FGE 38181	Fair	11-28-49	Wenatchee	Washington, D.C.	4 each tray packs BA, BB, CB 1/
	FGE 59166	Good	12-7-49	Wenatchee	Harlem River, N.Y.	4 CP - transit and market
	FGE 59185	Good	12-7-49	Wenatchee	Harlem River, N.Y.	4 CPK - " " "
Late Winter	PFE 67816	Good	3-11-50	Cashmere	Waverly, N.J.	4 each Std. CPK, CPI, CPD, CP 1/ 2 each Std. CPK, CPI, CP, Size 113 2/ 6 Ply-Veneer, 2 Std. Size 80 2/
	FGE 39073	Fair	3-22-50	Chelan	New York Auction	4 Std. - transit and market
Late Winter - Early Spring	WFE 49150	Fair	3-30-50	Dryden	Harlem River, N.Y.	8 each tray packs BA, BB, CB 1/
Early Spring	WFE 49258	Fair	4-13-50	Chelan	No. Hawthorne, N.J.	4 each 1/ 2 each Ply-Veneer-2 Std. Size 80 2/
	NRC 18487	Good	4-15-50	Chelan	New York Auction	4 Std. - transit and market

1/ Included packages for transit and market distribution bruise studies.

2/ Included only boxes going through to the retail store.

TABLE 4 - RELATION OF PACKAGE TO APPLE BRUISES FOUND AFTER SHIPMENT AND DELIVERY TO THE RETAIL STORE. WENATCHEE, WASH. TO NEW YORK, NEW JERSEY, AND WASHINGTON, D.C. OCTOBER 1949 TO APRIL, 1950

Package No.	Type	Apples Examined Number	Sound Apples Percent	Multi-bruised[1] Percent	Bruises per 100 Apples Slight	Severe	Total
1	Box, (Auction)[2] Sulphite liner	600	14.7	49.3	137.3	87.7	225.0
1	Box[3] Sulphite liner	600	14.7	46.5	136.3	61.5	197.8
2	Box; 4-way Cor.pads No tier pads	600	24.5	29.7	123.8	40.3	164.1
3	Box; 4-way Cor.pads Crepe tier pads	600	27.7	27.8	99.8	41.3	141.1
4	Box; 4-way Cor.pads Indent tier pads	600	28.0	24.5	102.2	34.1	136.3
5	Box; 4-way Cor.pads Kimpak tier pads	600	34.5	19.8	92.0	25.5	117.5
6	Box; tray pack[4] Type A tray	600	30.3	20.5	97.0	24.0	121.0
7	Box; tray pack Type B tray	600	31.8	23.5	108.5	27.8	136.3
8	Carton; tray pack Type B tray	600	34.8	24.0	98.3	31.0	129.3

1/ Multi-bruised: Apples having at least 3 slight (1/2 to 3/4 inch) bruises, or one severe (3/4 inch or larger) plus one other bruise of 1/2 inch minimum dimension.

2/ Boxes unloaded commercially for auction with simulated handling through wholesale channels to retail store.

3/ Boxes unloaded and handled through commercial channels to chain retail stores.

4/ Boxes and cartons with tray pack were subjected to the additional handling for loading tests.

TABLE 5 - COMPARISON OF BRUISES ON APPLES IN HEAVY AND LIGHT PACKS 1/

WENATCHEE, WASH. TO NEW YORK - NEW JERSEY
MARCH--APRIL 1950

Package	Pack	Fruits Examined Number	Sound Apples Percent	Multi-bruised2/ Percent	Bruises per 100 Apples Slight	Severe3/	Total
Box; sulphite liner	Heavy	226	8.9	61.9	177.8	88.9(10.1)	266.8
do	Light	200	5.0	62.5	178.5	86.5(8.5)	265.0
Box;corrugated pads	Heavy	226	6.2	70.8	161.1	131.8(22.5)	292.9
do	Light	200	17.5	50.5	152.0	74.5(4.0)	226.5
Box;corrugated pads indent tier pads	Heavy	226	17.3	39.4	125.6	72.2(7.9)	197.8
do	Light	200	32.5	21.0	104.5	24.5(0.5)	129.0
Box;corrugated pads Ximpak tier pads	Heavy	226	7.5	48.2	136.7	76.1(10.1)	212.8
do	Light	200	19.0	36.0	113.5	47.0(4.0)	160.5
Ply-wood box sulphite liners	Heavy	339	17.4	35.1	119.5	59.3(10.0)	178.8
do	Light	300	26.0	23.0	112.6	29.7(2.3)	142.3
Average of all types	Heavy	1243	12.0	49.6	141.9	83.3(12.0)	225.2
do	Light	1100	20.5	37.0	130.4	50.4(3.7)	180.8

1/ Data represent averages of counts made after shipment and delivery to retail stores.

2/ Multi-bruised: Apples having at least 3 slight (1/2 to 3/4 inch) bruises, or one severe (3/4 inch or larger) plus one other bruise of 1/2 inch minimum dimension.

3/ Figures in brackets indicate the severe bruises that were over 1 inch in diameter.

TABLE 6 - BRUISES ON APPLES PACKED IN NEW TYPE PLY-VENEER BOXES AFTER DELIVERY TO RETAIL STORES IN THE NEW YORK AREA.

SUMMARY OF TWO SHIPPING TESTS MARCH-APRIL 1950

Package	Fruits	Average Sound Apples Percent	Average Multi-bruised1/ Percent	Average bruises per 100 apples Slight	Severe	Total
		Size 100 - light pack				
A - Ply-Veneer	300	26.0	23.0	112.6	29.7	142.3
B - Ply-Veneer	300	14.3	33.3	144.0	47.3	191.3
C - Ply-Veneer	300	30.0	22.7	96.7	34.0	130.7
D - Ply-Veneer	300	25.3	32.0	114.0	43.0	157.0
Check-Standard Box2/	300	14.7	43.7	138.3	53.7	192.0
		Size 113-heavy pack				
A - Ply-Veneer	339	17.4	35.1	119.5	59.3	178.8
Check-Standard Box2/	226	8.8	61.9	177.9	88.9	266.8
		Size 80 - light pack				
B - Ply-Veneer	240	5.4	64.6	172.9	105.0	277.9
C - Ply-Veneer	240	7.9	53.7	154.2	77.1	231.3
D - Ply-Veneer	240	9.6	54.6	181.7	71.7	253.3
Check-Standard Box3/	240	10.0	64.2	177.5	119.6	297.1

1/ Multi-bruised: Apples having at least 3 slight (1/2 to 3/4 inch) or one severe (3/4 inch or larger) plus one other bruises of 1/2 inch minimum dimension.

2/ Apples in check boxes sizes 100 and 113 were more mature than those in Ply-Veneer boxes.

3/ Apples in check boxes size 80 were of same maturity as those in Ply-Veneer boxes.

TABLE 7 - BRUISES ON APPLES CAUSED DURING DIFFERENT PHASES OF APPLE SHIPMENT AND DISTRIBUTION.1/
WENATCHEE, WASH. TO NEW YORK - NEW JERSEY
OCTOBER 1949 TO APRIL 1950

Phase of handling	Fruits Examined Number 2/	Multi-bruised 3/ Percent	Bruises per 100 apples		
			Slight	Severe	Total
Loading Cars	4500	11.3	50.3	9.9	60.2
In transit	3600	9.1	26.3	10.1	36.3
Between cars and retail stores 4/	3600	16.9	37.5	29.7	67.4

1/ Stated as averages of bruises on apples packed with wraps in wood boxes and handled throughout the shipping season.

2/ Boxes held 100 apples all of which were examined.

3/ Multiple-bruised: Apples having at least 3 slight (1/2 to 3/4 inch) bruises, or one severe (3/4 inch or larger) plus one other bruise of 1/2 inch minimum dimension.

4/ Includes boxes moving through auction and chain store channels.

TABLE 8 - BRUISES CAUSED DURING CAR LOADING WITH APPLES IN TRAY-PACKS.1/
WENATCHEE, WASH.- 1949-1950

Package	Date Tested	Apples Examined Number	Multi-bruised2/ Percent	Bruises per 100 apples Slight	Severe	Total
Box, type A tray	10-17-49	400	4.0	17.0	3.2	20.2
	1-9-50	400	17.7	54.0	17.0	71.0
	3-23-50	400	5.5	28.7	3.7	32.5
Average during Season		-	9.1	33.2	8.2	41.4
Box, type B tray	10-17-49	400	0.7	10.7	1.2	12.0
	1-9-50	400	22.2	58.7	24.0	82.7
	3-23-50	400	8.0	26.0	6.5	32.5
Average during Season		-	10.3	31.8	10.6	42.4
Carton type B tray	10-17-49	400	4.0	12.2	2.5	2.5
	1-9-50	400	12.0	29.2	10.5	39.7
	3-23-50	400	7.7	21.7	11.7	33.5
Average during season		-	7.9	21.0	8.2	29.2

1/ Averages of differences on same apples before and after loading.

2/ Multi-bruised: Apples having at least 3 slight (1/2 to 3/4 inch) bruises, or one severe (3/4 inch or larger) plus one other bruise of 1/2 inch minimum dimension.

TABLE 9 - RELATION OF TIME OF HANDLING TO APPLE BRUISING 1/

Time of Handling	Fruits Examined Number	Sound Apples Percent	Multi-bruised 2/ Percent	Bruises per 100 apples Slight	Severe	Total
		After Transit				
Fall shipments	1200	60.0	6.7	50.4	9.9	60.3
Winter shipment	1200	36.2	20.7	99.2	22.4	121.6
Spring shipments	1200	32.4	20.4	83.3	23.7	107.1
		After delivery to retail store				
Fall shipments	1200	25.8	26.4	105.9	35.3	141.2
Winter shipments	1200	16.1	47.4	141.1	75.1	216.2
Spring shipments	1200	30.2	25.0	98.7	34.8	133.5

1/ Stated as averages of bruises found on apples packed with wrappers in wood boxes.

2/ Multi-bruised: Apples having at least 3 slight (1/2 to 3/4 inch) bruises, or one severe (3/4 inch or larger) plus one other bruise of 1/2 inch minimum dimension.

Figure 1. Wood box with 4-way (top, bottom and sides) corrugated pads and crepe paper tier-pads (see table 1).

Figure 2. Wood box with 4-way (top, bottom and sides) corrugated pads and indent paper tier pads (see table 1).

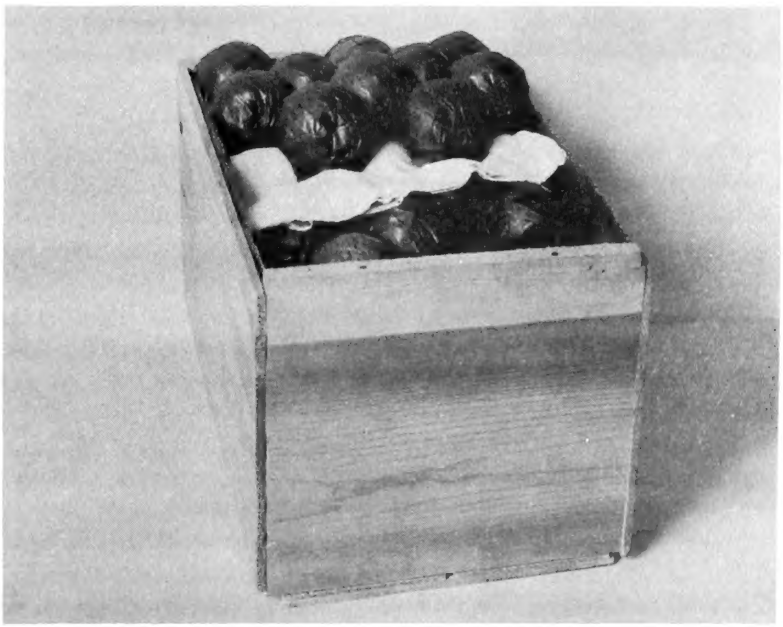
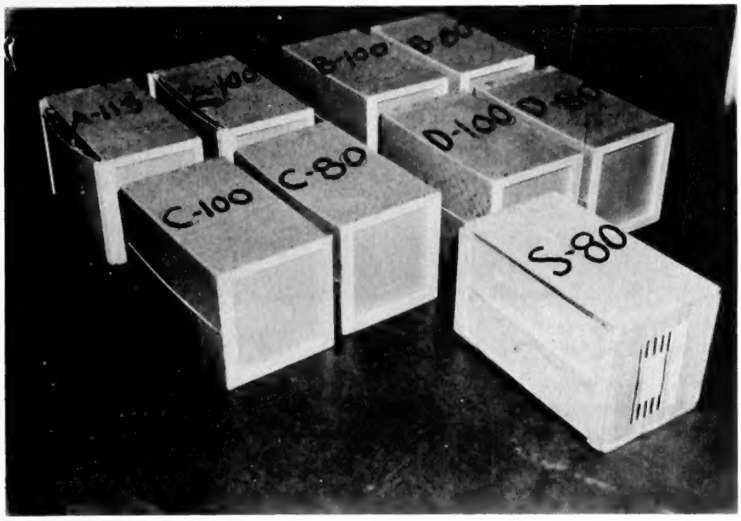


Figure 3. Wood box with 4-way (top, bottom and sides) corrugated pads and Kimpak cellulose tier pads. (see table 1)



A

B

Figure 4. Ply-Veneer boxes after transit and delivery to the retail store. (A) Letters on boxes denote style of package indicated in table 1. (B) Same package as in (A) after opening.